# Space Weather Technical Forecast

Issued on Friday, 23 February 2024 at 01:23 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: High solar activity associated with AR3590.**
**Current strongest flare of the solar cycle recorded with a chance of further X-class flares.**

**Solar Activity:** Solar activity has been High over the past 24 hours, with an impulsive X1.7 recorded at 22/0632UTC and most recently a flare of X6.4 recorded at 22/2234UTC, currently the strongest flare of the solar cycle, both from AR3590 in the northeast. AR3590 continues to be by far the largest and most complex of the currently three sunspot regions on the visible disc, with small delta spots remaining in evidence despite some slight consolidation in recent hours. All other spot simple or small however signs on the southeastern limb suggest the imminent arrival of further active region, with the region in the far southeast likely the previously highly active ex-AR3575, this responsible for an M1.5 flare at 22/0014UTC.

A large filament was observed leaving the northwest of the disc around 21/1730UTC and may give a glancing blow late on 24 Feb or early on 25 Feb. Another CME appeared to originate in the area around ex-AR3575, but has been analysed as missing Earth. The first X-class flare appears not to have produced a CME, while we await coronagraph imagery for what looks likely to be a CME associated with the X6.4 flare, visible as brief dimming on SDO/AIA imagery.

**Solar Wind / Geomagnetic Activity:** Solar winds, as observed by ACE have been at ambient speed throughout, and density has been below average. Total magnetic field strength has been weak, below 8nT, with the north-south component initially varying weakly +6/-6nT but becoming weakly positive from 22/1700UTC. Phi angle was firmly positive (away from the Sun). Geomagnetic activity was Quiet (Kp1-2).

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux was just above normal background levels but well below the S1/Minor Radiation Storm threshold. Electron flux (greater than 2MeV) observed at GOES16 has been at normal background levels, with electron fluence well below the Active (1e8 integrated pfu) threshold. The observed 24-hour fluence at 23/0001UTC was 1.05e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Activity is forecast to remain Moderate to High, with occasional M-class flares expected and a chance of further X-class flares, particularly in the short term, from AR3590. This risk allowed to decline towards more expected statistical levels into the period pending further developments of AR3590 and classification of oncoming regions.

**Solar Wind / Geomagnetic Activity:** A large filament was observed leaving the northwest of the disc around 21/1730UTC and is modeled to perhaps give a glancing blow late on day 2 (24 Feb) or more likely early on day 3 (25 Feb). No other CMEs currently feature in the forecast. Current solar winds are near background values but the high speed stream associated with CH01/- currently near centre disk is expected to connect with Earth perhaps as early as day 2 (24 Feb) but more likely by day 3 (25 Feb), and persist through the remainder of the period. Peak speeds expected around 500km/s.

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Geomagnetic activity is forecast to remain Quiet initially. Unsettled to Active intervals are then considered likely due to the onset of the high speed stream on days 2 and 3 (24/25 Feb), with a chance of G1/Minor storm intervals, particularly if connection to the high speed stream and the glancing blow from the filament CME occur at similar times.

**Energetic Particles / Solar Radiation:** GOES18 high energy (greater than 10MeV) proton flux is expected to continue at generally background levels or just above, but AR3590 will become an increasing source of potential proton response as the region moves towards and beyond centre disc through the forecast period, with a slight but increasing chance of S1 Minor Radiation Storms.

High energy electron flux (greater than 2MeV) is expected to generally remain at normal background levels, although an increase to moderate or high levels is perhaps possible by day 4 (26 Feb). 24-hour electron fluence is expected to stay below the Active (1e8 integrated pfu) threshold throughout

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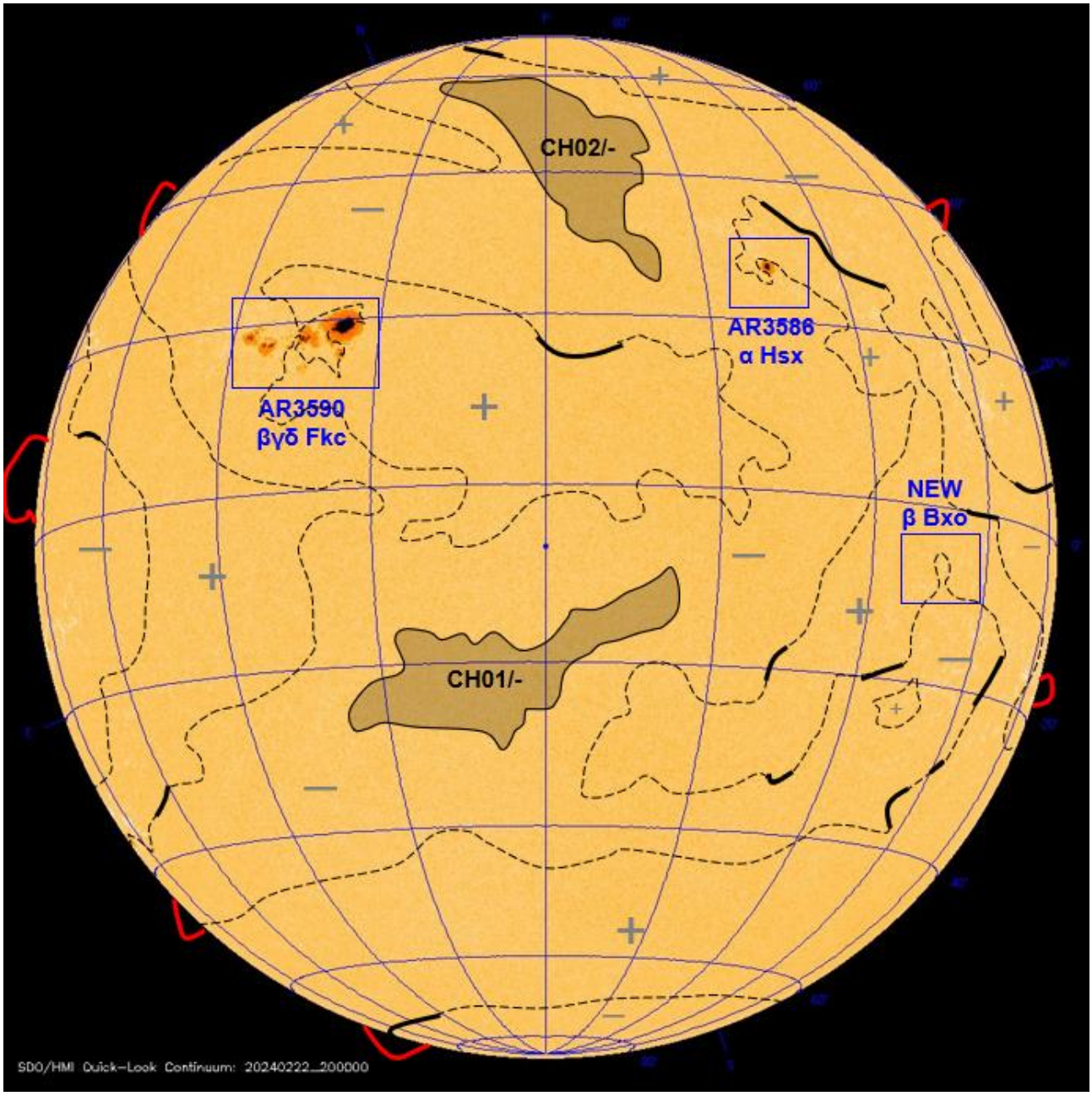
**Figure 1. Solar Analysis Valid 22/2000UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

A large filament was observed leaving the northwest of the disc around 21/1730UTC and is modeled to perhaps give a glancing blow late on day 2 (24 Feb) or more likely early on day 3 (25 Feb). No other CMEs currently feature in the forecast.

Current solar winds are near background values but the high speed stream associated with CH01/- currently near centre disk is expected to connect with Earth perhaps as early as day 2 (24 Feb) but more likely by day 3 (25 Feb), and persist through the remainder of the period. Peak speeds associated with this feature on the last rotation reached around 500km/s, with similar values considered likely. Geomagnetic response was fairly muted on the last rotation although expected response may be slightly stronger as we move closer to the March equinox. Geomagnetic activity is forecast to remain Quiet initially. Unsettled to Active intervals are then considered likely due to the onset of the high speed stream on days 2 and 3 (24/25 Feb), with a chance of G1/Minor storm intervals, particularly if connection to the high speed stream and the glancing blow from the filament CME occur at similar times.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 10 | 30 | 10 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 22/0257 | Partial | Filament Eruption | NW | 425 km/s | 25/1000UTC | Glancing blow |

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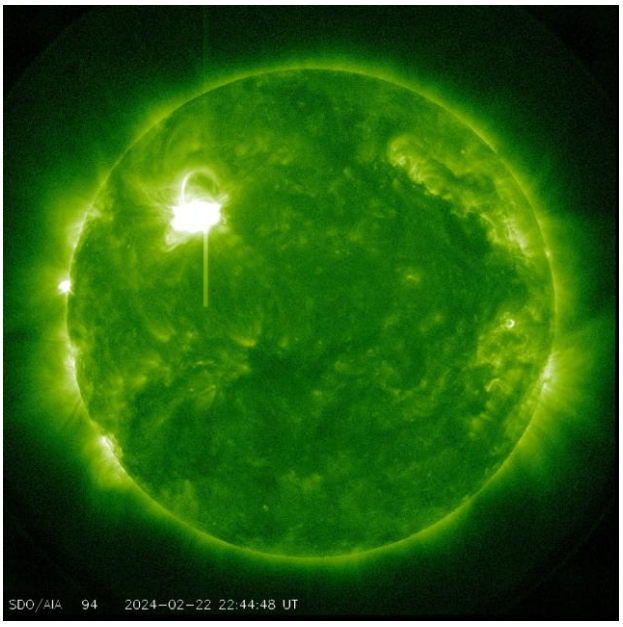
## Radio Blackouts - X-Ray Flares:

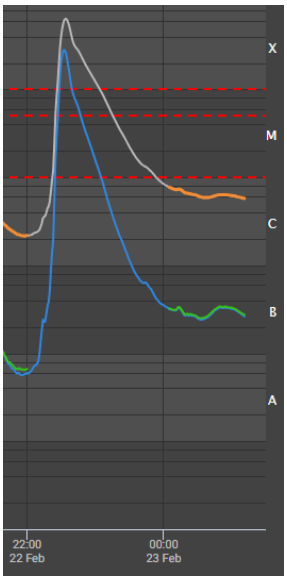
Solar activity has been High in the past 24hrs, with an X1.7 at 22/0632UTC and most recently a flare of X6.3 recorded at 22/2234 UTC, both from AR3590. This region appears to be extremely active, with several small delta spots remaining in evidence despite some apparent slight consolidation in recent hours. All other spots are simple or small however signs on the southeastern limb suggest the imminent arrival of further active region, with the region in the far southeast perhaps the previously highly active Ex-AR3575. These regions likely act to further increase flare risk in the coming hours and day given evidence of recent activity, however we await a better view before the risk can be fully assessed.

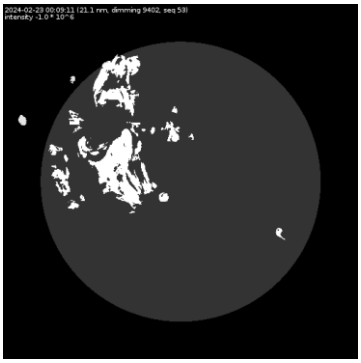
For now activity is forecast to remain Moderate to High, with occasional M-class flares expected and a chance of further X-class flares, particularly in the short term, from AR3590. This risk allowed to decline towards more expected statistical levels into the period pending further developments of AR3590 and classification of oncoming regions.

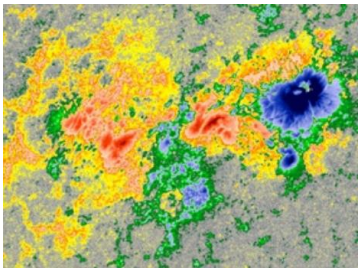
| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 80 | 80 | 80 | 80 |
| Very Active | R3 to R5 X Class | Yes | 50 | 40 | 30 | 25 |

**Figure 2: SDO/AIA 94 imagery showing X6.4 flare from leading portion of AR3590, GOES16/18 X-Ray trace of event, solar demon dimming detection output indicative of some CME release and latest magnetogram imagery of AR3590.**





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**Solar Radiation Storms - (High Energy Protons):**
GOES18 high energy (greater than 10MeV) protons have been around or slightly above background levels.

We currently await any potential proton response from the recent X6.3 flare from AR3590 although significant enhancement is not expected give the current position of this region. AR3590 will become an increasing source of potential proton response as the region moves towards and beyond centre disc through the forecast period however, particularly given the recent history of activity, with a slight but increasing chance of S1 Minor Radiation Storms.

| Radiation Storms<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 15 | 20 | 25 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux (greater than 2MeV) is currently at background levels, with any significant enhancement from glancing CME blow or high speed stream into days 2 and 3 (24/25 Feb) likely to be observed later in this forecast period, with an increase to moderate or high levels perhaps possible by day 4 (26 Feb).

Electron fluence values are expected to remain below the Active threshold during the forecast period with MOSWOC REFM model currently thought to be giving good guidance.

| GEO Electron Environment | Level ($cm^{-2}\ sr^{-1}\ day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 1 | 1 | 5 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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